1,123,822

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,123,822

Inventor: ROLAND TAYLOR

Date of filing Complete Specification (under Section 3(3) of the Patents Act 1949): 17 Jan., 1966.

Application Date: 30 March 1965. No. 3592/68.

(Application Date: 16 July, 1965. No. 3593/68.

Divided out of No. 1,123,821).

Complete Specification Published: 14 Aug., 1968.

Index at acceptance:—C1 AK4

Int. Cl.:—C 01 b 31/08

COMPLETE SPECIFICATION

Impregnated Activated Charcoal

We, UNITED KINGDOM ATOMIC ENERGY AUTHORITY, London, a British Authority, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to activated charcoal, primarily for fission product trapping systems for nuclear installations.

It is possible that as a result of certain types of nuclear reactor accidents which have been postulated, fission products will be released from irradiated nuclear fuel in substantial amounts and these fission products will find their way into the reactor coolant circuit. Therefore, before allowing reactor coolant to escape to the environment after an accident, fission products likely to present a hazard must be retained and to this end trapping systems have been developed for use in such circumstances. The same type of trapping system has also been used to remove fission products from the gases exhausted from other nuclear installations (e.g. irradiated fuel storage, breakdown or examination caves, and processing plants). Suggested trapping systems generally comprise a combination of high efficiency filters for removing particulate matter and a bed of activated charcoal provided to retain fission product vapour, of which iodine and its compounds are known to be the most important, produced during release of fission products from irradiated nuclear fuel. It has been found, however, that alkyl iodides, particularly methyl iodide, form a significant fraction of the iodine compounds and that difficulty may be experienced in effectively trapiing these alkyl iodides if the vapour passing through the trapping system has a relatively high humidity (greater than about 20%). This difficulty is enhanced by the economic requirement that the contact time between the charcoal and the vapour should be as small as possible.

[Pric

In our copending application Serial No. 3007/65 (Serial No. 1,123,821) there is disclosed a nuclear installation having a fission product trapping system which includes activated charcoal impregnated with a water-soluble secondary or tertiary amine. The present invention consists in activated charcoal impregnated with piperazine or triethylamine.

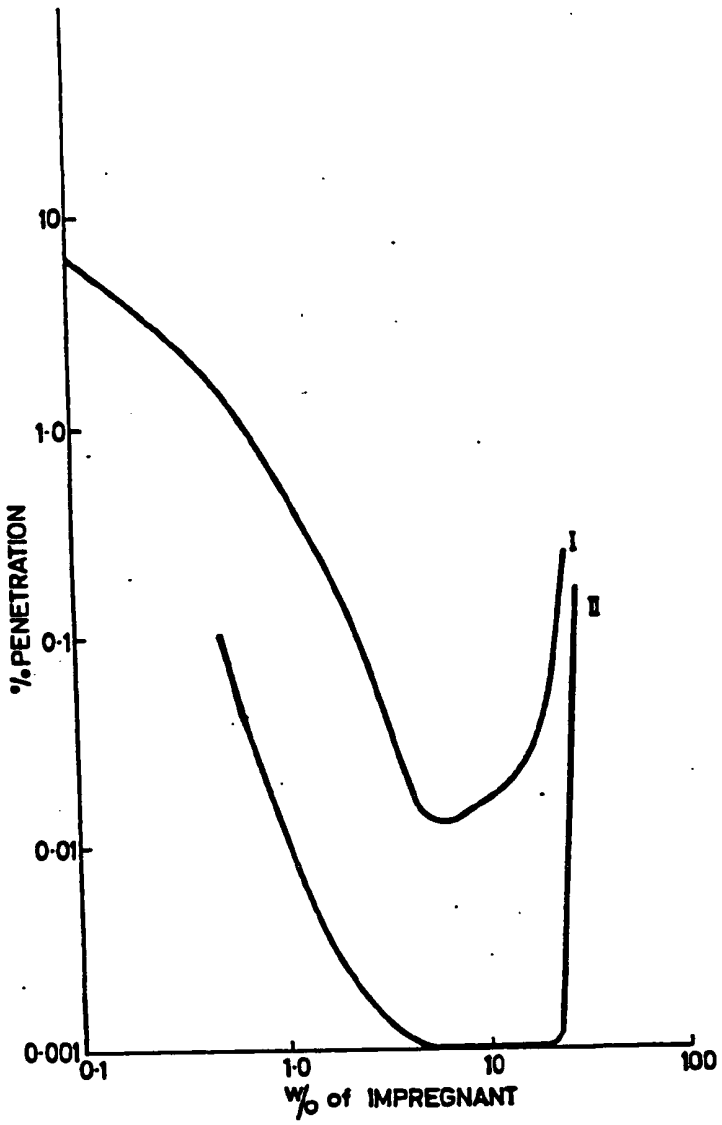
Piperazine is a preferred impregnant if gas flow through the impregnated charcoal is prolonged or at high temperature. For retaining methyl iodide in a carrier gas which is substantially carbon dioxide or which is flowing very rapidly in large quantities triethylene diamine is considered particularly suitable as an impregnant.

To demonstrate the effect of a trapping system including activated charcoal in accordance with the invention gas carrying methyl iodide labelled with iodine 131 was passed through a demister, a glass fibre paper filter with a high efficiency for aerosols and then through a bed of impregnated charcoal 6" deep by 1" diameter. The carrier gas was air or carbon dioxide at a relative humidity between 99% and 100% measured at the operating temperature of the charcoal bed (usually 20°C). The gas velocity at the face of the bed was varied between 20 and 120 linear ft/minute. The amount of methyl iodide which penetrated through the absorbent bed was indicated by comparing samples of gas from upstream and downstream of the absorbent bed and this was checked by the amount of methyl iodide remaining on the bed at the end of the experiment. In all experiments the charcoal beds were equilibrated with the carrier gas at the appropriate relative humidity for 16 hours (i.e. until the outgoing gas from the bed had the same relative humidity as the inlet gas). The bed was loaded with the methyl iodide over a period of 10 minutes and was then eluted with the appropriate carrier gas for four hours.

The following results were obtained:—

1123822 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*



Impregnated charcoal % (by weight)	Weight of CH_3I loaded to bed ($\mu gCH_3I/g$ charcoal)	Carrier gas		Face velocity at bed ft/minute	Percentage of total methyl iodide penetrating through bed in four hours
		Air %	CO_2 %		
Piperazine					
10%	100		100	20	0.07
10%	100	100		20	<0.0005
Triethylene diamine					
5%	100	100		20	<0.0005
5%	100	100		120	0.005
5%	100		100	50	0.005

To illustrate the performance of piperazine under conditions of high temperature and prolonged gas flow a bed of coal-based charcoal impregnated with 5% of piperazine and prividing a gas stay-time of 1.5 sec. was loaded with 100 μg methyl iodide per gram of charcoal over a period of about 15 minutes in a flow of steam which was condensing in the bed and raising its temperature from 20°C to about 100°C. The bed was then heavily lagged and steam at 110°C passed through it for 10 hours. The total penetration of methyl iodide through the bed in this time was 0.03% which increased only to 0.034% after a further 125 hours exposure of the bed to a flow of saturated air at room temperature. A further quantity of methyl iodide was then pesented to the bed in saturated air at room temperature, making 200 μg methyl iodide per gram charcoal in all. The cumulative penetration during the succeeding two hours increased to 1.5% but did not increase further during the next 135 hours exposure to the flow of saturated air. Such a charcoal bed is therefore capable of providing a decontamination factor of about 100 to methyl iodide for a 1½ second stay-time under extreme conditions of operation.

The preferred method of impregnation is to soak coal-based charcoal in an aqueous solution of the amine and then allow the water to evaporate off. Gentle heating to 100—120°C is allowable. other standard impregnation techniques such as spraying may be used provided no impurities are introduced to the charcoal with the amine solution. Effectiveness does not necessarily increase with increase in weight of impregnant however, and the accompanying graph shows the variation in penetration with triethylene diamine impregnated charcoal (Curve I) and piperazine impregnated charcoal (Curve II) as the weight of impregnant increases. The results were obtained by experiments similar to those already described, the contact time for Curve I being approximately 0.2 secs. and for Curve II approximately 1.5 secs.

WHAT WE CLAIM IS:—

Activated charcoal impregnated with piperazine or triethylenediamine.

J. Y. LE MASURIER,
Chartered Patent Agent,
Agent for the Applicants.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1968.
Published by the Patent Office, 25 Southampton Buildings, London, W.C.2, from which copies may be obtained.